ANTI-THEFT DEVICE OF VEHICLE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a national stage application under 35 U.S.C. § 371 of PCT Application No. PCT/JP2004/018696 designating the United States, filed December 15, 2004. The PCT Application was published in Japanese as WO 2005/080154 A1 on January 9, 2005 and claims the benefit of the earlier filing date of Japanese Patent Application No. 2004-356376, filed December 9, 2004, which claims the benefit of the earlier filing date of Japanese Patent Application No. 2004-048005, filed February 24, 2004. The contents of Japanese Patent Application No. 2004-356376, Japanese Patent Application No. 2004-048005, and International Application No. PCT/JP2004/018696 including the publication WO 2005/080154 A1 are incorporated herein by reference in their entirety.

BACKGROUND OF THE INVENTIONS

Field of the Inventions

[0002] The present inventions relate generally to anti-theft devices, and more specifically, to an anti-theft device for a vehicle such as a four-wheeled vehicle or a motorcycle.

Description of Background Art

[0003] A conventional vehicle anti-theft device provides anti-theft operation that can be set by a user when the vehicle is not in use, for example, by turning off the ignition switch of vehicle. However, since the user may not desire to set or arm the anti-theft device every time the ignition is turned off (for example, during fueling of the vehicle at a gas stand), other anti-theft devices have been developed that are not armed if the key of ignition switch is positioned at a position other than the OFF position when the engine is not running. In addition, another type of anti-theft device has been developed in which the anti-theft device can be disarmed if the key of ignition switch is operated to a position other than the ON position when the ignition switch is turned on from a condition in which the anti-theft has been set (*see e.g.* Japanese Laid-open Patent Publication No. 211564/2000).

[0004] As indicated above, prior art vehicle anti-theft devices often require the user to turn the ignition switch key to a position other than the OFF position in order to prevent the anti-theft device from being armed after the ignition switch is turned off, for example, during fueling of the vehicle. This complicates the operation of the anti-theft device. In addition, due in part to its complicated operation, the user might forget to properly position the key when turning the vehicle off. Such action could result in the unintentional and unconscious arming of the anti-theft device. Of course, the user later realizes that the device has been armed when the user accidentally trips the device and causes the alarm to sound, which can be annoying to the user as well as those in the vicinity of the vehicle.

SUMMARY OF THE INVENTIONS

[0005] According to some embodiments, there is provided a vehicle anti-theft device better helps users to avoid accidentally triggering the alarm. For example, the device can have an anti-theft caution condition which prevents the generation of unintentional alarm sounds and/or disabling the engine. Further, in some embodiments, the user can easily select whether to set the anti-theft caution condition, in accordance with the user's preference.

[0006] In accordance with an embodiment, a vehicle anti-theft device can comprise at least one of an alarm means and an immobilizer means. The alarm means can generate an alarm upon detection of theft. The immobilizer means can prevent the starting of engine upon detection of theft. Further, at least one of the alarm means and the immobilizer means can be set to an anti-theft caution condition when an ignition switch of vehicle is turned off, and can be set under a condition in which a dimmer switch is either in a high-beam or a low-beam position.

[0007] In some embodiments where the position of the dimmer switch is used in relation to the setting of the alarm, the device can be configured such that the user can freely adjust the setting of the alarm means and the immobilizer means corresponding to the position of the dimmer switch.

[0008] In accordance with another embodiment, the vehicle anti-theft device can be configured with at least one of the alarm means and the immobilizer means being set to an anti-theft caution condition when an ignition switch of vehicle is turned off and under a condition in which a headlight is either in lighting or lighting-off.

[0009] In accordance with yet another embodiment, a user can freely configure the device such that the alarm means and the immobilizer can be set or not depending on whether the headlight is in a lighting or lighting-off state.

[0010] In accordance with yet another embodiment, there is provided an anti-theft device comprising at least one of an alarm means for generating alarm on detection of theft and an immobilizer means for preventing the start of engine on detection of theft. At least one of the alarm means and the immobilizer means can be set to a caution condition in accordance with a combination of a high-beam or a low-beam position of a dimmer switch and a lighting or lighting-off state of a headlight.

[0011] In accordance with yet another embodiment, a setting confirmation sound can be generated when the alarm means or the immobilizer means is set.

[0012] In accordance with yet another embodiment, the alarm means can comprise a hazard warning lamp flashing means for flashing hazard warning lamps during operation of the alarm means and a hazard warning lamp flashing switch. In one implementation, the alarm means can start the flashing of the hazard warning lamps by the hazard warning lamp flashing switch under a condition in which the caution means is not set.

[0013] In accordance with yet another embodiment, the alarm means can be a piezoelectric buzzer. The alarm means can further comprise a control section having an oscillating means for controlling the anti-theft device and for generating a signal for the piezoelectric buzzer. Further, the alarm means can also comprise a piezoelectric driving section for driving the piezoelectric buzzer. In addition, the control section, the piezoelectric buzzer driving section, and the piezoelectric buzzer can be formed as a unit.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] Additional advantages and features of embodiments of the present inventions will become apparent from the subsequent description and the appended claims, taken in conjunction with the accompanying drawings, wherein:

[0015] Figure 1 is a block diagram showing an arrangement of a first embodiment of a vehicle anti-theft device;

[0016] Figure 2 is a block diagram showing a detailed arrangement of the first embodiment of the vehicle anti-theft device;

[0017] Figure 3 is a flow chart showing the operation of the first embodiment of the vehicle anti-theft device;

[0018] Figure 4 is a flow chart showing the operation of a second embodiment of the vehicle anti-theft device;

[0019] Figure 5 is a flow chart showing the operation of a third embodiment of the vehicle anti-theft device;

[0020] Figure 6 is a flow chart showing the operation of a fourth embodiment of the vehicle anti-theft device; and

[0021] Figure 7 is a schematic view showing yet another embodiment of the vehicle anti-theft device.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0022] Various embodiments and features of the present invention will be hereinafter described with reference to accompanied drawings. Embodiments of the vehicle anti-theft device can prevent theft of vehicles such as four-wheeled vehicles and motorcycles. Further, embodiments of the present invention can include means for detecting the theft and informing persons around the vehicle and/or its user of the theft.

First embodiment

[0023] FIG. 1 is a block diagram showing an arrangement of a first embodiment of the vehicle anti-theft device 1; FIG. 2 is a block diagram showing a detailed arrangement of the first embodiment of the vehicle anti-theft device 1; and FIG. 3 is a flow chart showing the operation of the first embodiment of the vehicle anti-theft device 1.

[0024] As shown in FIGS. 1-3, the vehicle anti-theft device 1 can comprise an anti-theft control circuit 5 and relays 6, 7, and 8. As shown in FIG. 1, the vehicle anti-theft device 1 can be connected to one or more of the following: an ignition switch 10, a dimmer switch 15, a headlight 16, a sensor 17, an electronic control unit ("ECU") 11, a turn signal lamp (L) 25, a turn signal lamp (R) 26, an alarm means 20, and an indicator 21.

[0025] The ignition switch 10 can be a main switch of the vehicle, and as is known in the art, an engine of the vehicle can be started by turning the ignition switch 10 "ON". The ECU 11 can be used for controlling the engine. The ignition switch 10 can control "ON/OFF" of electric power supply to the ECU 11. The "ON/OFF" control between

the ignition switch 10 and the ECU 11 can be carried out by contact points of the relay 6. In an exemplary embodiment, if the ignition switch 10 is not set "ON", electric power will not be supplied through the contact points 6 to the ECU 11 and consequently, the engine cannot be started; as described further herein, such an immobilizing condition can result from one implementation of the immobilizer means. Additionally, the "ON" or "OFF" state of the ignition switch 10 can be previously inputted to the anti-theft control circuit 5.

[0026] As illustrated in FIG. 2, the turn signal lamp (L) 25 and the turn signal lamp (R) 26 can be "OR" connected to a circuit (not shown) "ON/OFF" controlled by a turn signal switch. Further, the turn signal lamp (L) 25 and the turn signal lamp (R) 26 can be lit by the control from the anti-theft device 1. For example, the relay 7 can be set "ON" to light the turn signal lamp (L) 25 and the relay 8 can be set "ON" to light the turn signal lamp (R) 26. The dimmer switch 15 can be a switch for setting the high beam position or the low beam position of the headlight 16. The position of the dimmer switch 15 may also have been previously inputted to the anti-theft control circuit 5. The position "ON" or "OFF" of the headlight can also be inputted to the anti-theft control circuit 5.

[0027] The anti-theft control circuit 5 can be formed by a microcomputer (CPU) and an input/output circuit. The anti-theft control circuit 5 can control the vehicle anti-theft device 1 using a dedicated program. However, other means such as a sequencer or a logic circuit can be used for controlling the circuit 5. The alarm means 20 can be a sound generator, such as a buzzer. The indicator 21 can be configured to indicate the operating condition of the vehicle anti-theft device 1, and can include LEDs or lamps. The sensor 17 can be, for example, an acceleration sensor, a gravity sensor, etc., for detecting unintentional movement of vehicle by detecting inclination or vibration of vehicle. The indicator 21 can be arranged such that a driver of the vehicle can easily visually perceive whether the indicator 21 is illuminated. Although the mounting position of the anti-theft device 1 is not limited, it can be preferable to select a place that prevents removal of the device 1 from outside of the vehicle.

[0028] Although the embodiments shown in FIGS. 1 and 2 can include two immobilizer means for inputting the ignition switch 10 to relay 6, it is contemplated that other embodiments of the anti-theft device 1 can include at least one immobilizer means. In

addition, although embodiments can be structured so that respective states of the dimmer switch 15 and the headlight 16 can be inputted, it is contemplated that in other embodiments, at least one of the states of at least one of the dimmer switch 15 and the headlight 16 can be inputted into the anti-theft device 1. Furthermore, according to other embodiments, the turn signal lamps (L, R) 25 and 26 do not need to be turned on, i.e. illuminated.

[0029] Exemplary operation of embodiments of the anti-theft device 1 will now be described. Reference numerals enclosed in brackets in the following description correspond to those shown in an exemplary flow chart of FIG. 3.

[0030] In accordance with an implementation of the present invention, the anti-theft device 1 can be configured with the dimmer switch 15 in a low beam position or a high beam position. The operation of an embodiment of the device 1, wherein the dimmer switch 15 is in the low beam position, will now be described (such an embodiment is included in Table 1 below as No. 1). Nevertheless, it is also noted that Table 1 shows several combinations of settings obtained from positions of the dimmer switch 15. Other such details of Table 1 are described further below.

[0031] **[Table 1]**

		Dimmer switch	
		Low position	High position
No.1	Alarm+Immobilizer	Set	—
No.2	Alarm+Immobilizer	—	Set
No.3	Alarm	Set	—
No.4	Alarm	—	Set
No.5	Immobilizer	Set	—
No.6	Immobilizer	—	Set

[0032] Referring now to the flowchart illustrated FIG. 3, the "ON" or "OFF" state of the ignition switch 10 is initially observed (S101). When the ignition switch 10 is turned "OFF", confirmation of the position of the dimmer switch 15 can be carried out (S102). Thus, in accordance with an embodiment, with the ignition switch turned "OFF", and the dimmer

switch 15 in the high beam position, the device 1 will not be shifted to the anti-theft caution condition. Thus, turning the ignition switch 10 "OFF" would only cause the engine to stop (S102-Hi), and would not set the anti-theft caution condition (S103) of the device 1.

[0033] However, when the dimmer switch 15 is in the low beam position (S102-low), the device 1 can be set to the anti-theft caution condition (S103). When the device 1 is set to the anti-theft caution condition, a setting confirmation sound can be generated that indicates that the device 1 has been set to the anti-theft caution condition. The setting confirmation sound can be generated by using the alarm means 20. In addition, the immobilizer means can be operated so that the relay 6 is turned "OFF" in order to prevent start of the engine. In addition, according to an implementation of the device 1, the setting of the device 1 to the anti-theft caution condition can be indicated by flashing of the indicator 21 (S104). At this point, the driver can leave his (or her) vehicle.

[0034] Referring still to FIG. 3, if the key is inserted to the ignition switch 10 and turned "ON" during the anti-theft caution condition (S105-ON), the anti-theft caution condition can be released (S108). The release of the anti-theft caution condition can include turning off the indicator 21 and deactivating the immobilizer means by turning the relay 6 "ON".

[0035] While the device 1 is set to the anti-theft caution condition, operation of the sensor 17 can be observed by the anti-theft control circuit 5 (S106). If the sensor 17 detects unintentional vibration or movement of vehicle under the anti-theft caution condition (S106-Yes), the alarm can be triggered (S107). Triggering of the alarm can include the generation of an alarm sound by the alarm means 20. Additionally, the triggering of the alarm can also cause other manifestations, including flashing of the turn signal lamps (L, R) 25 and 26.

[0036] As described above, the device 1 can be set to the anti-theft caution condition when the ignition switch 10 of vehicle is turned "OFF" and the dimmer switch 15 is in the low beam position. Indeed, in one implementation, when the ignition switch 10 is turned "OFF", setting the device 1 to anti-theft caution condition depends only on whether the dimmer switch 15 is in the high or low beam position. The facility of selection tends to ensure that the driver will not trigger an unintentional alarm sound and disable start of the

engine. That is, when the driver does not want to set the device 1 (such as when the driver leaves the vehicle unattended within a short range), the device 1 can be easily operated, the anti-theft caution condition can be easily controlled, and unintentional generation of alarm sound and disability of start of the engine can be prevented, only by setting the dimmer switch 15 at the high beam position.

[0037] As described above, the alarm means and the immobilizer means can be set when the dimmer switch 15 is in the low beam position, as shown in No.1 in Table 1. However, according to another embodiment of the device 1, the alarm means and the immobilizer means can be set when the dimmer switch 15 is in the high beam position, as shown in No. 2 in Table 1. In another embodiment of the device 1, it is possible that only the alarm means can be set when the dimmer switch 15 is in the low beam position, as shown in No. 3 in Table 1. In yet another embodiment of the device 1, it is also possible that only the alarm means can be set when the dimmer switch 15 is in the high beam position, as shown in No. 4 in Table 1. In yet another embodiment of the device 1, it is possible that only the immobilizer means can be set when the dimmer switch 15 is in the low beam position, as shown in No. 5 in Table 1. In yet another embodiment of the device 1, it is possible that only the immobilizer means can be set when the dimmer switch 15 is in the high beam position, as shown in No. 6 in Table 1. Finally, in yet another embodiment of the device 1, not limited to the combinations in Table 1, it is possible that at least one of the alarm means and the immobilizer means can be set to the anti-theft caution condition when the ignition switch 10 is turned "OFF" and the dimmer switch 15 is either in the high beam or the low beam position. Various other combinations and configurations can also be implemented. In any case, implementations of the device 1 can allow easy and ready determination as to whether the device 1 should be set to the anti-theft caution condition or not. It is contemplated that such facility of selection can tend to prevent unintentional generation of the alarm sound and disabling the start of the engine.

[0038] In any of the embodiments described above, the driver can select a given setting (such as those illustrated in Nos. 1-6 of Table 1) at which the device 1 will be operated. The device 1 can be configured such that the selection of the setting is done in a secured manner, such as by providing a switch in the anti-theft control circuit 5. In this

regard, the driver can freely select the operational setting of the device 1 according to the preference of the driver, the destination of vehicle, the type of vehicle, and/or the cost of vehicle. Further, such a setting capability may also reduce the manufacturing cost of the device 1.

[0039] According to an implementation of the device 1, the driver can also easily know whether the device 1 is set to the anti-theft caution condition. For example, as mentioned above, the setting confirmation sound can be generated when the device 1 has been set to the anti-theft caution condition. Furthermore, it is possible to signal to the driver that the device 1 is not set, for example, by providing the device 1 with the hazard warning lamp flashing switch that can commence the flashing of the hazard warning lamps if the device 1 is not set. Such a feature can be easily added to a vehicle that does not have the hazard warning lamp flashing function by providing the anti-theft device 1 with such a function.

Second embodiment

[0040] FIG. 4 is a flow chart showing the operation of another embodiment of the anti-theft device 1.

[0041] Similar to the device 1 shown in FIGS. 1-2, the anti-theft device 1 represented in FIG. 4 can comprise the anti-theft control circuit 5 and relays 6, 7, and 8. Additionally, the ignition switch 10, the dimmer switch 15, the headlight 16, the sensor 17, the ECU 11, the turn signal lamp (L) 25, the turn signal lamp (R) 26, the alarm means 20, and the indicator 21 can be connected to the device 1. Since each of these structural elements can be the same as that of the embodiment described above, a detailed description of these elements will not be repeated. As mentioned above, although the embodiment shown in FIGS. 1 and 2 can include two immobilizer means for inputting the ignition switch 10 to relay 6, it is sufficient for the anti-theft device 1 to include at least one immobilizer means. In addition although the arrangement can be structured so that respective states of the dimmer switch 15 and the headlight 16 can be inputted, input of at least one of these states can be sufficient. Furthermore, lighting of the turn signal lamps (L, R) 25 and 26 is not necessarily required.

[0042] Exemplary operations of the device 1 of the embodiment represented in FIG. 4 will be now be described. Reference numerals enclosed in brackets in the following description correspond to those shown in a flow chart of FIG. 4.

[0043] In accordance with another implementation of the present invention, the device 1 can be configured with the headlight 16 in a lighting state or a lighting-off state. The operation of an embodiment of the device 1, wherein the headlight 16 is in the lighting state, will now be described (such an embodiment is included in Table 2 below as No. 1). Nevertheless, it is also noted that Table 2 shows several combinations of settings obtained from state of the headlight 16. Other such details of Table 2 are described further below.

[0044] **[Table 2]**

		Headlight	
		Lighting state	Lighting-off state
No.1	Alarm+Immobilizer	Set	—
No.2	Alarm+Immobilizer	—	Set
No.3	Alarm	Set	—
No.4	Alarm	—	Set
No.5	Immobilizer	Set	—
No.6	Immobilizer	—	Set

[0045] Referring now to the flowchart illustrated in FIG. 4, the "ON" or "OFF" state of the ignition switch 10 is initially observed (S201). When the ignition switch 10 is turned "OFF", confirmation of the state of the headlight 16 is carried out (S202). Thus, in accordance with an embodiment, with the ignition switch 10 turned "OFF", and the headlight 16 in the lighting-off state, the device 1 is not shifted to the anti-theft caution condition. Thus, turning the ignition switch 10 "OFF" would only cause the engine to stop (S202-Lighting-off), and would not set the device 1 to the anti-theft caution condition (S203).

[0046] However, when the headlight 16 is in the lighting state (S202-Lighting), the device 1 can be set to the anti-theft caution condition (S203). When the device is set to the anti-theft caution condition , a setting confirmation sound can be generated that indicates that the device 1 has been set to the anti-theft caution condition. The setting confirmation

sound can be generated by using the alarm means 20. In addition, the immobilizer means can be operated so that the relay 6 is turned "OFF" in order to prevent start of the engine. In addition, according to an implementation of the device 1, the setting of the device 1 to the anti-theft caution condition can be indicated by flashing of the indicator 21 (S204). Thus the driver can leave his (or her) vehicle.

[0047] Referring still to FIG. 4, if the key is inserted to the ignition switch 10 and turned "ON" while the device 1 is in the anti-theft caution condition (S205-ON), the anti-theft caution condition can be released (S208). The release of the anti-theft caution condition can include turning off the indicator 21 and deactivating the immobilizer means by turning the relay 6 "ON".

[0048] While the device 1 is set to the anti-theft caution condition, operation of the sensor 17 can be observed by the anti-theft control circuit 5 (S206). If the sensor 17 detects unintentional vibration or movement of vehicle under the anti-theft caution condition (S206-Yes), the alarm can be triggered (S207). Triggering of the alarm can include the generation of an alarm sound by the alarm means 20. Additionally, the triggering of the alarm can also cause other manifestations, including flashing of the turn signal lamps (L, R) 25 and 26.

[0049] As described above, the device 1 can be set to the anti-theft caution condition when the ignition switch 10 of vehicle is turned "OFF" and the headlight 16 is in the lighting state. Indeed, in one implementation, when the ignition switch 10 is turned "OFF", setting the device 1 to anti-theft caution condition depends only on whether the headlight 16 is in the lighting or lighting-off position.. The facility of selection tends to ensure that the driver will not trigger an unintentional alarm sound and disable start of the engine. That is, when the driver does not want to set the device 1 (such as when the driver leaves the vehicle unattended within a short range), the device 1 can be easily operated, the anti-theft caution condition can be easily controlled, and unintentional generation of alarm sound and disability of start of the engine can be prevented, only by setting the headlight 16 at the light-off condition.

[0050] As described above, the alarm means and the immobilizer means can be set when the headlight 16 is in the lighting state, as shown in No.1 in Table 2. However,

according to another embodiment of the device 1, the alarm means and the immobilizer means can be set when the headlight 16 is in the lighting-off state, as shown in No. 2 in Table 2. In another embodiment of the device 1, it is possible that only the alarm means can be set when the headline 16 is in the lighting state, as shown in No. 3 in Table 2. In yet another embodiment of the device 1, it is also possible that only the alarm means can be set when the headlight 16 is in the lighting-off state, as shown in No. 4 in Table 2. In yet another embodiment of the device 1, it is possible that only the immobilizer means can be set when the headlight 16 is in the lighting state, as shown in No. 5 in Table 2. In yet another embodiment of the device 1, it is possible that only the immobilizer means can be set when the headlight 16 is in the lighting-off state, as shown in No. 6 in Table 2. Finally, in yet another embodiment of the device 1, not limited to the combinations in Table 2, it is possible that at least one of the alarm means and the immobilizer means can be set to the anti-theft caution condition when the ignition switch 10 is turned "OFF" and the headlight 16 is either in the lighting or the lighting-off state. Various other combinations and configurations can also be implemented. In any case, implementations of the device 1 can allow easy and ready determination as to whether the device 1 should be set to the anti-theft caution condition or not. It is contemplated that such facility of selection can tend to prevent unintentional generation of the alarm sound and disabling the start of the engine.

[0051] In any of the embodiments described above, the driver can select a given setting (such as those illustrated in Nos. 1-6 of Table 2) at which the device 1 will be operated. The device can be configured such that the selection of the setting is done in a secured manner, such as by providing a switch in the anti-theft control circuit 5. In this regard, the driver can freely select the operational setting of the device 1 according to the preference of the driver, the destination of the vehicle, type of vehicle, and/or the cost of the vehicle. Further, such a setting capability may also reduce the manufacturing cost of the device 1.

[0052] According to an implementation of the device 1, the driver can also easily know whether the device 1 is set to the anti-theft caution condition. For example, as mentioned above, the setting confirmation sound can be generated when the device 1 has been set to the anti-theft caution condition. Furthermore, it is possible to signal to the driver

that the device 1 is not set, for example, by providing the device 1 with the hazard warning lamp flashing switch that can commence the flashing of the hazard warning lamps if the device 1 is not set. Such a feature can be easily added to a vehicle that does not have the hazard warning lamp flashing function by providing the anti-theft device 1 with such a function.

Third embodiment

[0053] FIG. 5 is a flow chart showing the operation of another embodiment of the anti-theft device 1.

[0054] Similar to the device 1 shown in FIGS. 1-2, the device 1 represented in FIG. 4 can comprise the anti-theft control circuit 5 and relays 6, 7, and8. Additionally, the ignition switch 10, the dimmer switch 15, the headlight 16, the sensor 17, the ECU 11, the turn signal lamp (L) 25, the turn signal lamp (R) 26, the alarm means 20, and the indicator 21 can be connected to the device 1. Since each of these structural elements can be the same as that of the embodiments described above, a detailed description of these elements will not be repeated. As mentioned above, although the embodiment shown in FIGS. 1 and 2 can include two immobilizer means for inputting the ignition switch 10 to relay 6, it is sufficient for the anti-theft device 1 to include at least one immobilizer means. In addition although the arrangement can be structured so that respective states of the dimmer switch 15 and the headlight 16 can be inputted, input of at least one of these states can be sufficient. Furthermore, lighting of the turn signal lamps (L, R) 25 and 26 is not necessarily required.

[0055] Exemplary operations of the device 1 of the embodiment represented in FIG. 5 will now be described. Reference numerals enclosed in brackets in the following description correspond to those shown in a flow chart of FIG. 5.

[0056] In accordance with another implementation of the present invnetion, the device 1 can be configured with respective states of the dimmer switch 15 and the headlight 16 determining whether the device 1 is set to the anti-theft caution condition. The operation of an embodiment of the device 1, wherein the dimmer switch 15 is in the low beam position and the headlight 16 is in the lighting state will now be described (such an embodiment is included in Table 3 as No. 1). Table 3 shows several combinations of settings obtained from

respective states of the dimmer switch 15 and the headlight 16. Other such details of Table 3 are described further below.

[0057] **[Table 3]**

	Dimmer switch	Headlight	Alarm	Immobilizer
No. 1	Low beam position	Lighting	Set	Set
No. 2		Lighting-off	Set	—
No. 3	High beam position	Lighting	—	Set
No. 4		Lighting-off	—	—

[0058] Referring now to the flowchart illustrated in FIG. 5, the "ON" or "OFF" state of the ignition switch 10 is initially observed (S301). When the ignition switch 10 is turned "OFF", confirmation of the position of the dimmer switch 15 is carried out (S302). Thus, in accordance with an embodiment, with the ignition switch 10 turned "OFF", and the dimmer switch 15 is in the high beam position, confirmation of the state of the headlight 16 is carried out (S310). When the headlight 16 is in the lighting-off state (No. 4 in Table 3), the device 1 is not set to the anti-theft caution condition. Thus, turning the ignition switch 10 "OFF" would only the engine to stop (S310-Lighting-off), and would not set the device 1 to the anti-theft caution condition (S303).

[0059] However, when the dimmer switch 15 is in the low beam position (S302-Low), the device 1 can be set to the anti-theft caution condition (S303). When the device 1 is set to the anti-theft caution condition, a setting confirmation sound can be generated that indicates that the device 1 has been set to the anti-theft caution condition. The setting confirmation sound can be generated by using the alarm means 20. In addition, according to one implementation, when the headlight 16 is in the lighting state, the relay 6 is turned "OFF" and the immobilizer means prevents start of the engine. According to another implementation, when the headlight 16 is in the lighting-off state, only the alarm means is set. In an additional implementation, when the dimmer switch 15 is in the high beam position and the headlight 16 is in the lighting state (S310-lighting), only the immobilizer means is set. Furthermore, in another implementation, the indicator 21 can flash to indicate

that the device 1 is now in the anti-theft caution condition (S304). Thus the driver can leave his (or her) vehicle.

[0060] Referring still to FIG. 5, if the key is inserted to the ignition switch 10 and turned "ON" while the device 1 is in the anti-theft caution condition (S305-ON), the anti-theft caution condition can be released (S308). The release of the anti-theft caution condition can include turning off the indicator 21 and deactivating the immobilizer means by turning the relay 6 "ON" (however, the immobilizer means can be unnecessary in the embodiments represented in Nos. 2 and 4 in Table 3).

[0061] While the device 1 is set to the anti-theft caution condition, operation of the sensor 17 can be observed by the anti-theft control circuit 5 (S306). If the sensor 17 detects unintentional vibration or movement of vehicle under the anti-theft caution condition (S306-Yes), if the alarm means is set, the alarm can be triggered (S307). Triggering of the alarm can include generation of an alarm sound by the alarm means 20. Additionally, the triggering of the alarm can also cause other manifestations, including flashing of the turn signal lamps (L, R) 25 and 26.

[0062] As described above, the device 1 can be set to the anti-theft caution condition when the ignition switch 10 of vehicle is turned "OFF", the dimmer switch 15 is in the low or high position, and the headlight 16 is in the lighting state. Thus, whether or not the device 1 is set to the anti-theft caution condition is determined by selecting a combination of the position (high beam position or low beam position) of the dimmer switch 15 and the state (lighting or lighting-off state) of the headlight 16. The facility of selection tends to ensure that the driver will not trigger an unintentional alarm sound and disable start of the engine. That is, when the driver does not want to set the device 1 (such as when the driver leaves the vehicle unattended within a short range), the device can be easily operated, the anti-theft caution condition can be easily controlled, and unintentional generation of alarm sound and disability of start of the engine can be prevented, only by selecting the combination of the position (high beam position or low beam position) of the dimmer switch 15 and the state (lighting or lighting-off state) of the headlight 16.

[0063] As described above, the alarm means and the immobilizer means can be set in accordance with the combination of the states shown in Table 3. However, according

to another embodiment of the device 1, the alarm means and the immobilizer means can be set with other combinations of the positions of the dimmer switch 15 and the states of the headlight 16. In accordance with yet other embodiments of the device 1, not limited to the combinations in Table 3, it is possible that at least one of the alarm means and the immobilizer means can be set to the anti-theft caution condition when the ignition switch 10 is turned "OFF" and other combinations of the position (high beam position or low beam position) of the dimmer switch 15 and the state (lighting or lighting-off state) of the headlight 16 are selected. In any case, implementations of the device 1 can allow easy and ready determination as to whether the device 1 should be set to the anti-theft caution condition or not. It is contemplated that such facility of selection can tend to prevent unintentional generation of the alarm sound and disabling the start of the engine.

[0064] In any of the embodiments described above, the driver can select a given setting (such as those illustrated Nos. 1-4 in Table 3) at which the device 1 will be operated. The device can be configured such that the selection of the setting is done in a secured manner, such as by providing a switch in the anti-theft control circuit 5. In this regard, the driver can freely select the operational setting of the device 1 according to the preference of the driver, the destination of the vehicle, the type of vehicle, and/or the cost of the vehicle. Further, such a setting capability may also reduce the manufacturing cost of the device 1.

[0065] According to an implementation of the device 1, the driver can also easily know whether the device 1 is set to the anti-theft caution condition. For example, as mentioned above, the setting confirmation sound can be generated when the device 1 has been set to the anti-theft caution condition. Furthermore, it is possible to signal to the driver that the device 1 is not set, for example, by providing the device 1 with the hazard warning lamp flashing switch that can commence the flashing of the hazard warning lamps if the device 1 is not set. Such a feature can be easily assed to a vehicle that does not have the hazard warning lamp flashing function by providing the anti-theft device 1 with such a function.

Fourth embodiment

[0066] FIG. 6 is a flow chart showing the operation of another embodiment of the anti-theft device 1.

[0067] Similar to the device 1 shown in FIGS. 1-2, the device 1 represented in FIG. 6 can comprise the anti-theft control circuit 5 and relays 6, 7, and8. Additionally, the ignition switch 10, the dimmer switch 15, the headlight 16, the sensor 17, the ECU 11, the turn signal lamp (L) 25, the turn signal lamp (R) 26, the alarm means 20, and the indicator 21 can be connected to the device 1. Since each of these structural elements can be the same as that of the embodiments described above, a detailed description of these elements will not be repeated. As mentioned above, although the embodiment shown in FIGS. 1-2 can include two immobilizer means for inputting the ignition switch 10 to relay 6, it is sufficient for the anti-theft device 1 to include at least one immobilizer means. In addition although the arrangement can be structured so that respective states of the dimmer switch 15 and the headlight 16 can be inputted, input of at least one of these states can be sufficient. Furthermore, lighting of the turn signal lamps (L, R) 25 and 26 is not necessarily required.

[0068] Exemplary operations of the device 1 of the embodiment represented in FIG. 6 will now be described. Reference numerals enclosed in brackets in the following description correspond to those shown in a flow chart of FIG. 6.

[0069] Referring now to the flowchart illustrated in FIG. 5, the "ON" or "OFF" state of the ignition switch 10 is initially observed (S401). When the ignition switch 10 is turned "OFF", confirmation of the position of the dimmer switch 15 is carried out (S402). Thus, in accordance with an embodiment, with the ignition switch 10 turned "OFF", and the dimmer switch 15 is in the high beam position, the device 1 is not set to the anti-theft caution condition. Thus, the operation of the ignition switch 10 would only cause the engine to stop (S402-Hi), and would not set the device 1 to the anti-theft condition (S403).

[0070] However, when the dimmer switch 15 is in the low beam position (S402-Low), the device 1 can be set to the anti-theft caution condition (S403). When the device 1 is set to the anti-theft caution condition, a setting confirmation sound can be generated that indicates that the device 1 has been set to the anti-theft caution condition. The setting confirmation sound can be generated by using the alarm means 20. Furthermore, in another implementation, the indicator 21 can flash to indicate that the device 1 is now in the anti-theft caution condition (S404). Thus the driver can leave his (or her) vehicle.

[0071] Referring still to FIG. 6, in accordance with another embodiment, if the key is inserted to the ignition switch 10 and turned "ON" while the device is in the anti-theft caution condition (S405-ON), the relay 6 can be turned "OFF" to actuate the immobilizer means so as not to enable start of an engine (S410). Then, when the dimmer switch 15 is turned from its low beam position to its high beam position (S411-Hi), the relay 6 can be turned "ON" to release the immobilizer means so as to enable start of an engine (S412) and to release the anti-theft caution condition (S408).

[0072] While the device 1 is set to the anti-theft caution condition, operation of the sensor 17 can be observed by the anti-theft control circuit 5 (S406). If the sensor 17 detects unintentional vibration or movement of vehicle under the anti-theft caution condition (S406-Yes), the alarm can be triggered (S407). Triggering of the alarm can include generation of an alarm sound by the alarm means 20. Additionally, the triggering of the alarm can also cause other manifestations, including flashing of the turn signal lamps (L, R) 25 and 26.

[0073] As described above, when releasing the anti-theft caution condition, it is also possible to observe the change of the state of the dimmer switch 15 and the headlight 16. By enabling the anti-theft caution condition to be released only when the several conditions are satisfied, it is possible to firmly achieve the anti-theft of vehicle.

[0074] Finally, an exemplary embodiment of the alarm means 20, which can be utilized in combination with the embodiments described above, is now provided. FIG. 7 shows a schematic view of an embodiment of the alarm means 20. The alarm means can comprise the anti-theft control circuit 5, a piezoelectric buzzer 20a, and a piezoelectric buzzer driving circuit 9 for driving the piezoelectric buzzer 20a. As previously described, the control circuit 5 can control the anti-theft device 1. The control circuit 5 can include an oscillating means for generating oscillating signals controlled by hardware or software. According to one example of the oscillating means controlled by software, "ON" and "OFF" of I/O port of CPU can be repeated by software and the oscillating signals can be generated by its repeating cycle. The piezoelectric buzzer driving circuit 9 can generate oscillating signals having sufficient electric power to drive the piezoelectric buzzer by superposing electric current on the oscillating signals from the control circuit 5. The control circuit 5, the

piezoelectric buzzer driving circuit 9, and the piezoelectric buzzer 20a can be formed on the same circuit board.

[0075] In anti-theft devices of the prior art, the oscillating circuit for generating the oscillating signals, the piezoelectric buzzer driving circuit, and the piezoelectric buzzer were integrally formed, and these structural elements were formed separately from the control circuit. The prior art control circuit would only control the "ON" and "OFF" of the piezoelectric buzzer. Accordingly, it was impossible to change the receiving frequency of the piezoelectric buzzer and sound pressure level from the anti-theft control circuit.

[0076] However, according to embodiments of the device 1 of the present invention, because the control circuit 5, the piezoelectric buzzer driving circuit 9, and the piezoelectric buzzer 20a can be integrally formed and the control circuit 5 can have the oscillating means, it is possible to change the oscillating frequency from the control circuit 5 and thus, it is possible to appropriately change sound tone of the piezoelectric buzzer. In addition, it is possible to adjust the sound pressure level of the piezoelectric buzzer 20a by using the frequency characteristics between the frequency and the sound pressure of the piezoelectric buzzer 20a. Furthermore, as shown in FIG. 7, when the piezoelectric buzzer 20a is used with its two inputs being inputted by oscillating signals having respectively opposite phases, it is possible to adjust the sound pressure by not inputting any oscillating signal to one input or by inputting oscillating signal of any phase difference not opposite signal.

[0077] The device 1 of the present invention can be applied to various kinds of vehicles having a dimmer switch and a headlight, such as a four-wheeled vehicle, a motorcycle, a buggy, a snowmobile, a snow vehicle, etc.

[0078] The present invention has been described with reference to the preferred embodiment. Obviously, modifications and alternations can occur to those of ordinary skill in the art upon reading and understanding the preceding detailed description. It is intended that the present invention be construed as including all such alternations and modifications insofar as they come within the scope of the appended claims or the equivalents thereof.